REMARKS

This Supplemental Preliminary Amendment, Information Disclosure Statement, and Request for an Interference, including these Remarks, sets forth in detail the reasons why the applicants believe that all claims pending in the present application are allowable and that an interference should be declared between the present application and U.S. Patent No. 6,071,077.

INTRODUCTION

The present application seeks reissue under 35 U.S.C. § 251 and 37 C.F.R. § 1.171 et seq. of U.S. Patent No. 5,642,985 in the names of David A. Spear (deceased), Bruce P. Biederman and John A. Orosa, and assigned to United Technologies Corporation of Hartford, Connecticut ("the UTC '985 Patent") (copy enclosed). The present application was filed to provoke an interference with U.S. Patent No. 6,071,077 in the name of Paul A. Rowlands and assigned to Rolls-Royce PLC of London, United Kingdom ("the Rolls '077 Patent") (copy enclosed).

This application seeks to enlarge the scope of the claims of the UTC '985 Patent. The application was filed on June 5, 2001, as a continuation of reissue Application No. 09/343,736 ("the UTC Parent Reissue Application"), which has been allowed and for which the issue fee is due on October 14, 2002. The amendment to the specification adds a government rights statement in wording identical to that used in the UTC Parent Reissue Application.

The UTC Parent Reissue Application was filed on June 30, 1999, less than two years from the grant of the UTC '985 Patent on July 1, 1997. It sought to enlarge the scope of the UTC '985 Patent. Accordingly, the applicants are entitled under 35 U.S.C. § 251 to seek a broadening reissue by the present application:

> [I]f intent to broaden is indicated in a parent reissue application within the two years, a broadened claim can be presented in a continuing reissue application after the two year period. Manual of Patent Examining Procedure ("MPEP") § 1412.03 (8th Ed., Aug. 2001), at 1400-18.

The present reissue application was filed with new claims 4-22; that is, original patent claims 1-3 were deleted. This Supplemental Preliminary Amendment cancels claims 4-9, 12, and 21 without prejudice to their reintroduction into the application should that be deemed appropriate at a later date, and adds new independent claim 23. Claims 10, 11, 13-20, 22, and 23 are now pending in this application, with claims 10, 18, and 23 being independent.

The changes made by this Supplemental Preliminary Amendment to claims 10, 11, 13, and 18 are detailed in attached Exhibit A, which underlines material added to the originally presented claims and places in brackets material deleted therefrom. Exhibit A sets forth all of the claims now in the application.

All of UTC's claims are based on claims in the Rolls '077 Patent, using slightly different wording from the patent claims. UTC's claims correspond to the Rolls '077 Patent claims as follows:

Present Application Claim	Rolls '077 Patent Claim
Claim 10	Claim 1 (modified)
Claim 11	Claim 2 (modified)
Claim 13	Claim 3 (modified)
Claim 14	Claim 4 (modified)
Claim 15	Claim 5 (identical)
Claim 16	Claim 6 (identical)
Claim 17	Claim 7 (identical)
Claim 18	Claim 8 (modified)
Claim 19	Claim 9 (identical)
Claim 20	Claim 10 (identical)
Claim 22	Claim 13 (identical)
Claim 23	Claim 8 (modified)

AN INTERFERENCE-IN-FACT EXISTS

Under 37 C.F.R. § 1.601(i), an interference exists when two parties are claiming either the identical invention, or inventions that are obvious from each other:

> An *interference* is a proceeding instituted in the Patent and Trademark Office before the Board [of Patent Appeals and Interferences] to determine any question of patentability and priority of invention between two or more parties claiming the same patentable invention. (Emphasis in original).

Under the definition of "same patentable invention" in 37 C.F.R. § 1.601(n), there is an interference when each party has at least one claim that is unpatentable relative to at least one claim of the other party:

> Invention "A" is the *same patentable invention* as an invention "B" when invention "A" is the same as (35 U.S.C. 102) or is obvious (35 U.S.C. 103) in view of invention "B" assuming invention "B" is prior art with respect to invention "A". Invention "A" is a *separate patentable invention* with respect to invention "B" when invention "A" is new (35 U.S.C. 102) and non-obvious (35 U.S.C. 103) in view of invention "B" assuming invention "B" is prior art with respect to invention "A". (Emphasis in original).

Where the parties do not have identical claims, as in the present case, at least one claim of each party must be obvious in view of at least one claim of the other party, assuming the other party's claim is prior art. Two-way obviousness is required; that is, party A must have a claim that is obvious from at least one of party B's claims, and vice versa. See Winter v. Fujita, 53 U.S.P.Q.2d 1234, 1243 (Bd. Pat. Apps. & Inter. 1999).

1. The Parties' Common Invention

Before discussing the precise relationship of the parties' claim language, it will be helpful to have some background regarding the subject matter of the Rolls '077 Patent and the UTC '985 Patent that is the precursor of the present reissue application.

Rolls '077 Patent and the UTC '985 Patent both relate to a fan stage of a ducted fan gas turbine engine with a particularly advantageous blade configuration. See, for example, UTC '985 Patent, Figs. 1 and 2, col. 1, lines 4-7; Rolls '077 Patent, col. 1, lines 7-10.

A fan in a large gas turbine engine rotates at speeds that produce supersonic flow over the fan blades at some point along the blade span. UTC '985 Patent, col. 3, lines 6-10; Rolls '077 Patent, col. 1, lines 31-33. This supersonic flow causes the formation of shock waves and reduces the efficiency of the fan. UTC '985 Patent, col. 3, lines 10-14; Rolls '077 Patent, col. 1, lines 38-41. The leading edge of a fan blade can be swept to mitigate these losses. UTC '985 Patent, col. 1, lines 27-31; Rolls '077 Patent, col. 3, lines 17-20. (The term "sweep angle" has an accepted definition, used in both the UTC '985 Patent, see col. 3, lines 20-29, and the Rolls '077 Patent, see col. 2, lines 5-10). Each of the UTC and Rolls fan blades has a leading edge with a forward swept inner region followed by a rearward swept intermediate region. The rearward sweep in the intermediate region is important because it increases the fan blade's efficiency by reducing the Mach number of the supersonic airflow in a direction perpendicular to the leading edge. UTC '985 Patent, col. 3, lines 14-18; Rolls '077 Patent, col. 3, lines 14-17. The forward sweep in the inner region is a known expedient, which makes the use of rearward sweep in the intermediate region practicable from the standpoint of the mechanical stresses on the entire blade. UTC '985 Patent, col. 5, 55-60; Rolls '077 Patent, col. 3, lines 30-33.

Although sweeping the intermediate region of the leading edge rearward is advantageous to some extent, it can also cause a shock to form in front (that is, upstream) of the blade in an outer region near the duct wall. UTC '985 Patent, Figs. 2 and 3; Rolls '077 Patent, Fig. 3a. That can result in a loss in operational efficiency, as well as possible fan failure. UTC '985 Patent, col. 3, lines 55-57; Rolls '077 Patent, col. 3, lines 41-45, col. 4, lines 11-17. The same feature in

each party's blade solves that problem: the blade leading edge outer region is translated or swept forward relative to the leading edge at the end of the intermediate region, to keep the shock within the interblade passage behind the leading edge. UTC '985 Patent, col. 4, line 63, to col. 5, line 4; Rolls '077 Patent, col. 4, lines 18-21, and col. 7, lines 28-30.

2. UTC Claim 18 and Rolls Claim 8 Define The Same Patentable Invention

UTC independent claim 18 and Rolls '077 Patent independent claim 8 have been chosen for this analysis because they are essentially broader in all respects relevant to the present inquiry than any other claim in the parties' respective cases.

The following chart highlights the precise differences between UTC claim 18 and Rolls claim 8:

Present Application Claim 18	Rolls '077 Patent Claim 8
A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:	A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:
a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region being convergent;	a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region being convergent;
a hub disposed concentrically relative to the fan casing;	a hub disposed concentrically relative to the fan casing;
a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:	a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:
a tip profile that substantially corresponds to the convergent inner duct wall of the fan casing;	a tip profile that is convergent so as to substantially correspond to the convergent inner duct wall of the fan casing;
a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:	a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:

an inner region adjacent the hub, the inner region defining a forward sweep angle;	an inner region adjacent the hub, the inner region defining a forward sweep angle;
an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and	an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and
an outer region between the intermediate region and the fan casing, the outer region being translated forward relative to the leading edge at an outward boundary of the intermediate region.	an outer region between the intermediate region and the fan casing, the outer region defining a forward sweep angle.

As for the obviousness of narrower Rolls claim 8 from broader UTC claim 18, consider the first limitation in Rolls's claim not found in UTC's claim, namely that the blade's tip profile "is convergent so as to substantially correspond to the convergent inner duct wall of the fan casing."

It would have been obvious to use a blade having a convergent tip profile for a number of reasons. First, fans with convergent casings and matching convergent fan blade tip profiles had been conventional for decades by the time of this invention, as shown by U.S. Patent 4,012,172 to Schwaar et al. (Fig. 1), U.S. Patent 4,408,957 to Kurzrock et al. (Fig. 1) and U.S. Patent 5,408,826 to Stewart et al. (Fig. 2) (copies enclosed).

In addition, the Rolls '077 Patent does not assert that a convergent duct wall and matching blade tip profile provides any advantage not already known to those skilled in the art. The Rolls '077 Patent, at column 6, lines 21-26, attempts to distinguish the use of a convergent casing from the configuration shown in the UTC '985 Patent. However, the Rolls '077 Patent misstates what the UTC '985 Patent says in that regard. The description in question in the UTC '985 Patent actually teaches that the casing wall can be made convergent to ameliorate the problem of pressure wave reflection, noting at the same time that mechanical and aerodynamic

constraints may not permit sufficient convergence to eliminate the problem. UTC '985 Patent, col. 3, lines 58-63. Then, just like the Rolls '077 Patent, the UTC '985 Patent says that the blade configuration provides the solution. Id., col. 3, lines 64-67.

In any event, it is abundantly clear that the prior art teaches the conventionality of providing UTC claim 18's fan with a convergent blade tip profile that substantially corresponds to the convergent wall casing. For example, Stewart, which discloses such structure, explains that it is important to make the radial clearance between the blade tip and the wall casing as small as possible. Stewart does this by providing an abradable coating 25 on the duct wall and cutting a path through the coating with the blade tips to ensure that the duct wall and converging blade tips conform exactly. Stewart, col. 3, lines 45-50.

The only other difference between these claims is that UTC claim 18 recites an outer region that is "translated forward relative to the leading edge at an outward boundary of the intermediate region." Rolls claim 8 recites this feature more narrowly, calling for an outer region "defining a forward sweep angle."

Once one skilled in the art had been taught by UTC claim 18 to translate the outer region forward, it would have been a matter of design choice and thus manifestly obvious to translate the outer region forward sufficiently to provide a forward sweep angle. That is, as discussed above, the object of the blade leading edge configuration recited in UTC claim 18 is optimizing fan efficiency by moving the tip region leading edge forward a sufficient distance to intercept the shock wave in the vicinity of the blade tip. (This is explicitly recited in UTC claim 23.) It would have been obvious to one of ordinary skill in the art, knowing that to be the purpose of this feature of claim 18, to have provided the blade tip leading edge with forward sweep if doing so would achieve the desired purpose for a particular fan under certain operating conditions. Stated

another way, UTC claim 18 recites a blade that reduces leading edge sweep in a tip region for the same reason as the blade recited in Rolls claim 8 (see Rolls '077 Patent, col. 4, lines 18-21). Accordingly, translating the leading edge at the tip of UTC's blade even further, to provide forward sweep, would have been obvious to one of ordinary skill in the art.

Therefore, Rolls claim 8 is clearly obvious from UTC claim 18.

In addition, UTC claim 18 is broader in all respects than Rolls claim 8, because claim 18 omits the limitation that the blade tip profile is convergent and recites that the outer region of the blade's leading edge is translated forward rather than swept forward. UTC claim 18 is anticipated by Rolls claim 8, since a narrow claim anticipates a broader claim. Chisum on Patents § 3.02[1], at page 3-14, and [2], at pages 3-20 to 3-21.

3. UTC Claims 10, 11, 13-20, 22, And 23 Are Patentable Over The Prior Art

All of UTC's claims, being based closely on counterparts in the Rolls '077 Patent, are patentable over the prior art for the same reasons as the Rolls '077 Patent claims.

Independent UTC claim 10 differs from Rolls claim 1 in the same respects as UTC claim 18 differs from Rolls claim 8, shown in the above chart at pages 9-10. The first difference is that UTC claim 10 does not recite a blade with a convergent tip profile. The second is that UTC claim 10 recites a translated-forward third height region, while Rolls claim 1 recites a swept-forward third height region. UTC independent claim 23 includes all of the limitations of UTC claim 18.

The prosecution of the Rolls '077 Patent application shows that the Patent and Trademark Office has found UTC's claimed subject matter patentable over the prior art. Rolls application claim 1, in its penultimate incarnation before allowance, had all of the limitations now appearing in Rolls '077 Patent claim 1, except for a convergent blade tip profile. In that form, in which the

claim included a forward swept third height region, the UTC '985 Patent was the only prior art standing in the way of allowance. Indeed, the Examiner deemed the UTC '985 Patent to anticipate Rolls application claim 1. Office Action dated August 18, 1999, in Application No. 09/168,968. (Copies of the papers referred to herein from this Rolls application are collected in attached Exhibit B.) In response, Rolls argued only that the UTC '985 Patent does not disclose a blade tip profile conforming to the duct wall (which, of course, it does). Rolls did not argue that the forward swept third height region imparted patentability to the claims. Amendment Under 37 C.F.R. § 1.111, filed November 10, 1999. In that same amendment, Rolls added new application claim 8 with wording like that in Rolls '077 Patent claim 8, but without a convergent blade tip profile.

In other words, the Examiner of the Rolls '077 Patent application found a claim with the limitations in present UTC claims 10, 18, and 23 to be patentable over all prior art of record except for the UTC '985 Patent. Therefore, the Patent and Trademark Office in effect deemed UTC independent claims 10, 18, and 23 patentable over the prior art, which means their respective dependent claims are likewise patentable over the prior art.

It was only after the Examiner suggested adding claim language reciting a convergent blade tip that the claims were allowed over the UTC '985 Patent. Interview Summary, November 19, 1999; Supplemental Amendment Under 37 C.F.R. § 1.115, filed November 30, 1999. (Of course, the Examiner did not have before him prior art like the Stewart patent, which teaches the conventionality of that feature.)

REQUEST FOR AN INTERFERENCE

1. Background

The UTC '985 Patent issued on Application No. 08/559,965, filed November 17, 1995 ("the Original UTC Application"). The Rolls '077 Patent issued on Application No. 09/168,968, filed October 9, 1998, which is a continuation-in-part of Application No. 08/819,269, filed March 18, 1997, now abandoned. The Rolls '077 Patent claims benefit of the April 9, 1996, filing date of U.K. Application No. 96073316.

Accordingly, no Rolls '077 Patent claim, whether or not it is entitled to benefit of Rolls's foreign priority date, has an effective filing date before UTC's effective filing date of November 17, 1995. Consequently, in an interference between the present reissue application and the Rolls '077 Patent, United Technologies Corporation will be the senior party and Rolls-Royce PLC will be the junior party.

UTC proposes that its claims 10, 11, 13-20, 22, and 23 (all of the reissue claims) and Rolls '077 Patent claims 1-13 (all of the patent claims) be involved in the interference.

2. Showing Under 37 C.F.R. § 1.607(a)

37 C.F.R. § 1.607(a) sets forth what an applicant must present in order to have an interference declared with an issued U.S. patent. Each such requirement is addressed below.

a. 37 C.F.R. § 1.607(a)(1) -- Identification of the Patent

The patent is the Rolls '077 Patent.

b. 37 C.F.R. § 1.607(a)(2) -- Proposed Count

UTC proposes that the interference be declared with a single count in accordance with the following proposed Count 1:

UTC claim 18 or Rolls claim 8.

For purposes of the following discussion, UTC claim 18 will be referred to as proposed Count 1(a) and Rolls claim 8 will be referred to as proposed Count 1(b). For the convenience of the Examiner, the full text of these alternative versions of proposed Count 1 are set forth in attached Exhibit C. See also the chart at pages 9-10 above.

These alternate versions of an interference count are put forward pursuant to Davis v. Uke, 27 U.S.P.Q.2d 1180 (Comm. of Pats. 1993), which instructs that "[t]he scope of a count of an interference should be such as to embrace all of the *patentable* subject matter of all claims corresponding to the count." Id. at 1186 (emphasis in original). If necessary, the count may be written in a form that includes alternate versions that recite subject matter of selected claims of the parties' claims in the alternative. Id. Of course, all of the alternate versions of the count must be to the same patentable invention. Orikasa v. Oonishi, 10 U.S.P.Q.2d 1996, 2003 (Comm. of Pats. 1989).

Additionally, each alternate version of the count must be obvious in view of the other version, assuming the other version is prior art. In other words, two-way obviousness is required; that is, count version (a) must be obvious from count version (b), and vice versa. See Winter v. Fujita, 53 U.S.P.Q.2d 1234 (Bd. Pat. Apps. & Inter. 1999). This requirement is satisfied because it was shown at pages 9-12 above that UTC claim 18 and Rolls claim 8 define a common invention and thus create an interference-in-fact.

Moreover, the proposed Count is such as to properly "embrace all of the patentable subject matter of all claims corresponding to the count." See Davis v. Uke, supra. As noted above, Count 1(a) and Count 1(b) are UTC claim 18 and Rolls claim 8, respectively. Comparing those claims with UTC independent claim 10 and Rolls independent claim 1, the latter two claims cover essentially the same subject matter as the proposed Count, plus reciting a blade

stagger angle that increases with blade height. Even though there are some differences in claim language between UTC claim 18 and Rolls claim 8, on the one hand, and UTC claim 10 and Rolls claim 1, on the other, the former claims (proposed Count 1) still "embrace the patentable subject matter" of the latter claims. They also clearly "embrace the patentable subject matter" of the parties' dependent claims. Finally, UTC independent claim 23 is narrower in all respects than UTC claim 18 (Count 1(a)), which thus "embraces" the subject matter of claim 23, also.

In summary, the proposed count is a proper vehicle for contesting priority in this case.

c. 37 C.F.R. § 1.607(a)(3) -- Rolls '077 Patent Claims 1-13 Correspond To Count 1

A claim corresponds to an interference count when they both define the same patentable invention. See 37 C.F.R. § 1.601(f) and (i); see also 37 C.F.R. § 1.606. The definition of the term "same patentable invention" is found in 37 C.F.R. § 1.601(n), quoted above. This "same patentable invention" inquiry requires two-way obviousness (count-to-claim and claim-to-count). All claims meeting that test correspond to proposed Count 1 and should be involved in the interference.

Turning to the Rolls '077 Patent claims, the difference between Rolls '077 Patent claim 1 and proposed Count 1(b) (other than differences in terminology that do not affect this analysis) is that claim 1 recites a "stagger angle which increases progressively with blade height," a limitation not found in the proposed count.

The blade's stagger angle (or "blade twist") increases progressively with blade height because the blade's circumferential velocity ("V_x" in Fig. 2 of Schwaar) progressively increases with blade height, while the axial airflow velocity ("V_y" in Fig. 2 of Schwaar) remains constant. As Schwaar points out, it is a "basic consideration of blade design" that the twist angle "t" shown in Fig. 2 increases with blade height. Schwaar, col. 3, line 66, to col. 4, line 21. Accordingly,

this limitation is not just obvious in view of proposed Count 1(b), it is an inherent feature of any fan blade.

Rolls '077 Patent claim 2 depends from claim 1 and reads as follows:

> A fan stage of a ducted fan gas turbine engine as claimed in claim 1 wherein the blade has a tip region of about 20% of blade height characterised in that the stagger angle increases to approximately 70° at the tip relative to the airflow direction.

Claim 2 recites a "tip region," but neither it nor its immediately preceding base claim 1 defines this term. Consequently, this claim essentially defines a region of the blade at the tip that constitutes an arbitrary amount of the blade's span. As a result, this limitation has no patentable significance.

However, if the recited "tip region" is taken as being that portion of the blade in which the leading edge transitions from rearward sweep to the forward swept third height region in claim 1, then it would have been obvious to chose any suitable place on the leading edge, such as 20% of the blade height, at which to begin the transition to forward sweep. Put another way, proposed Count 1(b) "teaches" a blade with a leading edge profile that has a forward swept outer region in order to provide certain aerodynamic advantages. A gas turbine engine designer of ordinary skill, knowing the purpose of Count 1(b)'s blade geometry, would have found it obvious to provide forward sweep in as much or as little of the blade region near the tip as would be necessary to accomplish that purpose.

As for the recitation of a stagger angle at the blade tip of approximately 70° relative to the airflow direction, this limitation would have been obvious for the same reasons that the recited extent of the forward swept tip region would have been obvious. That is, the engine designer, faced with a set of fan performance requirements, would have simply made the blade with a stagger angle at the tip that would provide optimum performance. That it might be 70° relative to

the airflow direction for a given fan stage is simply a matter of proper engineering design. Note also that the stagger angle "t" at the blade tip as measured in Fig. 2 of Schwaar is 70°.

Dependent claim 3 of the Rolls '077 Patent reads as follows:

> A fan stage of a ducted fan gas turbine engine as claimed in claim 2 wherein [*sic* - in?] a blade tip region of about 20% of blade height the sweep of the leading edge changes from rearward sweep to forward sweep.

This claim is obvious from proposed Count 1(b) for the same reasons as claim 2 discussed above.

Dependent claim 4 of the Rolls '077 Patent reads as follows:

> A fan stage of a ducted fan gas turbine engine as claimed in claim 3 wherein the blade is further characterised in that the stagger angle of the mid-height region of the blade is in the range from approximately 30° to approximately 55° relative to the airflow direction.

This claim is obvious from proposed Count 1(b) for the same reasons as claim 2 discussed above. That is, the stagger angle of a fan blade at any particular point on the blade is simply a function of good design technique after taking into account the operating conditions to be encountered by the blade. Note also that Fig. 6 of Schwaar shows a swept fan blade with a stagger angle between 30° and 55° in the blade mid-height region.

Dependent claim 5 of the Rolls '077 Patent reads as follows:

> A fan stage of a ducted fan gas turbine engine as claimed in claim 1 wherein the sweep angle of the leading edge of a swept fan blade at a point on the leading edge is less than the complement of the angle of a Mach cone at any other point on the leading edge of the blade at greater radius from the root.

To understand why this claim is obvious from proposed Count 1(b), it is first necessary to understand the concept of a "Mach cone."

Describing the effects of supersonic flow in terms of Mach cones and Mach angles is not new with the Rolls '077 Patent. U.S. Patent 3,989,406 to Bliss et al. (copy enclosed) is an example of an earlier reference that discusses Mach cone angles. Figs. 1C and 2 from Bliss, reproduced below, illustrate Mach cones associated with a blade leading edge:

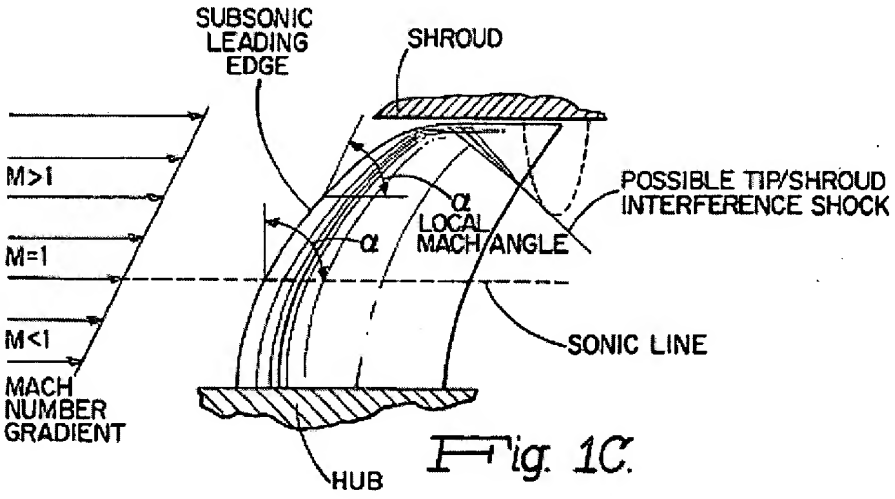

Fig. 1C.

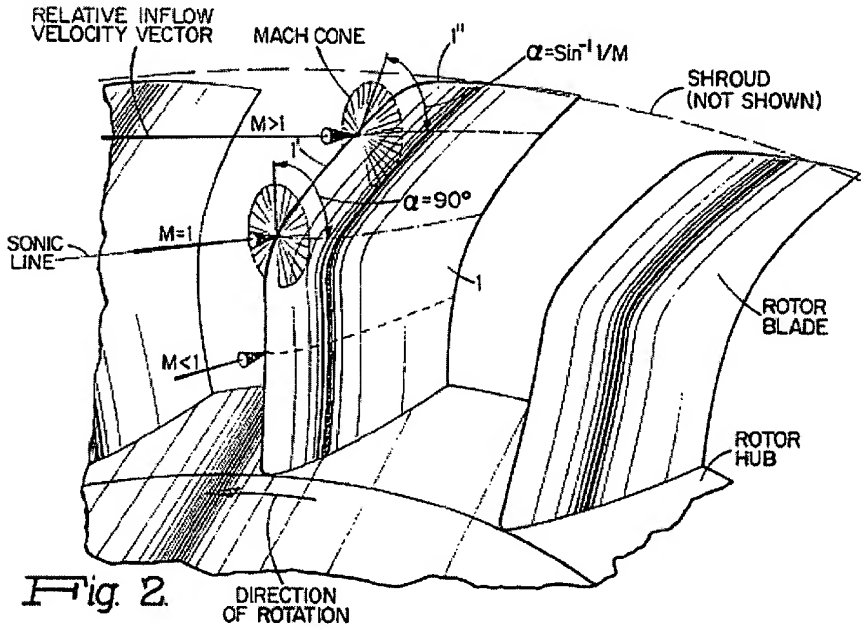

Fig. 2.

Figure 2 is a three-dimensional depiction of Mach cones associated with a fan blade leading edge. The Mach cone associated with a particular point is a theoretical construct that

makes it possible to envision the character of the flow associated with that point relative to the speed of sound. By definition, flow at the Mach cone normal to its surface is at the speed of sound. Accordingly, flow normal to a leading edge downstream of the Mach cone is subsonic.

Bliss Figures 1C and 2 illustrate this principle by showing that there is no Mach cone where $M < 1$, that the "cone" is planar at $M = 1$, and that for $M > 1$ the Mach cone angle α increases as the Mach number increases.

Bliss shows a blade with a leading edge swept to a degree that it is always subject to subsonic velocities, thus theoretically eliminating the difficulties associated with shock waves. In geometric terms, the sweep angle in Bliss is greater than the complement of the Mach cone angle α (sweep angle $\sigma > 90° - \alpha$).

Considering Rolls claim 5 in light of those known principles, its subject matter is not only obvious from proposed Count 1, but relates to an inherent feature of the blade recited in the proposed Count. That is, one of the reasons for using the blade configuration recited in the proposed Count is to account for the *presence* of shock waves in the flow over the blade. Accordingly, the leading edge of the blade is not swept sufficiently to eliminate those shock waves, which is exactly what is recited in claim 5. Put another way, if the leading edge of the Count's blade were swept sufficiently to eliminate shock waves, there would be no shock waves as depicted in Fig. 3 of the Rolls '077 Patent.

Dependent claim 6 of the Rolls '077 Patent reads as follows:

> A fan stage of a ducted fan gas turbine engine as claimed in claim 1 wherein the shape of the pressure surface of a swept fan blade and the suction surface thereof creates, in use, a line of minimum static pressure points on the suction surface of the blade, said line of minimum static pressure points is inclined with respect to the axial direction at a sweep angle which varies with span height of the blade, and has a negative value in a region of subsonic flow over the leading edge.

It will be appreciated immediately that, by definition, a gas turbine engine fan blade is an airfoil with a suction surface and a pressure surface. Accordingly, at each location along the blade height, the suction surface will have a minimum static pressure point. The locus of those points will, again by definition, be a line of minimum static pressure points.

As a practical matter, good blade design requires that the line of minimum static pressure points for a swept fan blade inherently follow the leading edge profile, as seen in U.S. Patent 4,726,737 to Weingold et al. (copy enclosed). In other words, given the geometry of proposed Count 1's blade and its leading edge sweep angle profile, its line of minimum static pressure points will be inclined at a sweep angle that varies with blade height, and that sweep angle will be negative in the inner, subsonic-flow region of the blade.

Dependent claim 7 of the Rolls '077 Patent reads as follows:

> A fan stage of a ducted fan gas turbine engine as claimed in claim 6 wherein the sweep angle of the line of minimum static pressure points at a point on the line is less than the complement of a Mach cone angle at any other point on the line.

This claim relates to the same concept as claim 5. Mach cones associated with a blade's line of minimum static pressure points were also known from Weingold, which is referred to in the Rolls '077 Patent at column 7, lines 25-27. Fig. 2a of Weingold illustrates Mach cones associated with a line of minimum static pressure points:

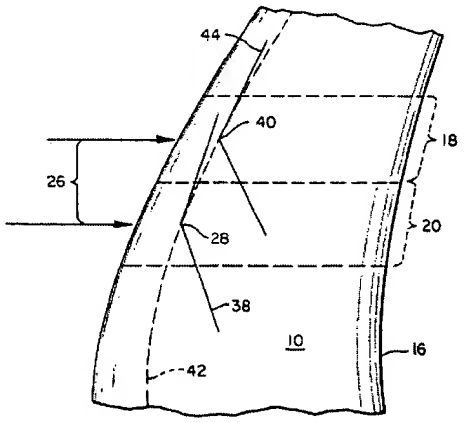

FIG. 2a

In Weingold the blade's maximum camber line 42 (associated with the line of minimum pressure points) is behind the Mach line associated with any inboard point of maximum camber. The reason for using this geometry is basically the same as the reason for using the severe sweep discussed in Bliss. What Rolls '077 Patent claim 7 says is that the blade need not be swept as severely as suggested in Weingold if the shock waves' adverse effects are dealt with by reducing sweep in the blade's tip region. That is, according to the claim language, the blade's line of minimum static pressure points is not swept sufficiently to eliminate those shock waves. This feature is inherently part of proposed Count 1's blade by the same reasoning discussed above in connection with claim 5.

Rolls '077 Patent independent claim 8 is identical to proposed Count 1(b), and is therefore to the same patentable invention.

Dependent claim 9 of the Rolls '077 Patent reads as follows:

> The fan stage according to claim 8, wherein the intermediate region extends further than the inner region along the axis of rotation.

This is a conventional feature of a swept fan blade, as seen in Figs. 4 and 6 of Schwaar.

Dependent claim 10 of the Rolls '077 Patent reads as follows:

> The fan stage according to claim 8, wherein the inner duct wall of the fan casing at the fan rotor region is substantially convergent in the downstream direction.

Initially, this is already a feature of proposed Count 1(b), which means that it adds nothing to distinguish it from the subject matter of the proposed Count. This is also a conventional feature of a ducted fan gas turbine engine, as discussed above in connection with the obviousness of Rolls claim 8 from the subject matter of UTC claim 18.

Dependent claim 11 of the Rolls '077 Patent reads as follows:

> The fan stage according to claim 8, wherein the tip profile of the swept fan blades are substantially convergent in the downstream direction.

As with claim 10, this is already a feature of proposed Count 1(b), which means that it adds nothing to distinguish it from the subject matter of the proposed Count. This is also a conventional feature of a ducted fan gas turbine engine, as discussed above in connection with the obviousness of Rolls claim from the subject matter of UTC claim 18.

Dependent claim 12 of the Rolls '077 Patent reads as follows:

> The fan stage according to claim 8, wherein inner duct wall of the fan casing is not parallel to the tip profile of each of the multiple swept fan blades.

This claim actually contradicts proposed Count 1(b), which recites that the blade tip profile is configured to "substantially correspond to the convergent inner duct wall." Nonetheless, it would have been well within the skill of a gas turbine engine designer to use a fan casing with an inner wall that is not parallel to the blade tip profile, as shown in U.S. Patent 4,012,165 to Kraig (Fig. 1; movable door 32) (copy enclosed).

Dependent claim 13 of the Rolls '077 Patent reads as follows:

> The fan stage according to claim 8, wherein each of the multiple swept fan blades includes a hub contacting surface that extends further than the tip profile along the axis of rotation.

The configuration of a gas turbine engine fan blade is determined largely by performance parameters that are set for the engine designer. This claim relates to physical properties of the blade rather than its aerodynamic performance. Nothing has been found in the Rolls '077 Patent disclosure to indicate that the features recited in this claim are anything more than the result of an engine designer of ordinary skill determining optimum blade geometry within the parameters

given. Fig. 4 of Schwaar shows a swept fan blade with the claimed relationship between the blade root and tip.

Accordingly, all of Rolls claims are either anticipated by or obvious from Count 1. By the same token, all of Rolls claims, being narrower than the Count, anticipate the Count. Chisum on Patents, supra.

d. 37 C.F.R. § 1.607(a)(4) -- UTC Claims 10, 11, 13-20, 22, and 23 Correspond To Count 1

The difference between proposed Count 1(a) and UTC claim 10 is that the claim recites a "stagger angle which increases progressively with blade height," a limitation not found in the proposed Count. This is the same manner in which Rolls '077 Patent claim 1 differs from proposed Count 1(b). UTC claim 10 is obvious from proposed Count 1 for the same reasons discussed above in connection with Rolls '077 Patent claim 1.

Dependent UTC claims 11 and 13-17 are either identical to or based closely on dependent claims 2-7 of the Rolls '077 Patent, respectively. To the extent they differ from those Rolls '077 Patent claims, they are broader. Accordingly, they are to the same patentable invention as the proposed Count for the reasons discussed in connection with those Rolls '077 Patent claims.

Independent UTC claim 18 is identical to proposed Count 1(a), and is therefore to the same patentable invention as the proposed Count.

Dependent UTC claims 19, 20, and 22 are either identical to or based closely on dependent claims 9, 10, and 13 of the Rolls '077 Patent, respectively. To the extent they differ from those Rolls '077 Patent claims, they are broader. Accordingly, they are to the same patentable invention as proposed Count 1 for the reasons discussed in connection with those Rolls '077 Patent claims.

Regarding UTC claim 23, it includes functional language setting out the purpose of the blade configuration recited in both proposed Count 1(a) and proposed Count 1(b). As such, it merely states an advantage inherent in the proposed Count's subject matter, and thus would have been obvious therefrom.

Accordingly, all of UTC's claims are either anticipated by or obvious from proposed Count 1. By the same token, all of UTC's claims, being narrower than the proposed Count, anticipate the proposed Count. Chisum on Patents, supra.

e. 37 C.F.R. § 1.607(a)(5) -- The Present Application Supports UTC Claims 10, 11, 13-20, 22, and 23

The following discussion applies the terms of UTC's claims to the disclosure of the present UTC reissue application. The disclosure of the present application is identical to the disclosure of the Original UTC Application, which therefore supports UTC's claims in exactly the same fashion as the present application. Accordingly, claims 10, 11, 13-20, 22 and 23 do not introduce prohibited new matter into the application in contravention of 35 U.S.C. § 251.

(1) Independent Claim 10

Independent claim 10 is based closely on claim 1 of the Rolls '077 Patent. The following claim chart applies the terms of claim 10 to the disclosure in the present application.

Present Application Claim 10	Present Application Disclosure
A fan stage of a ducted fan gas turbine engine comprising:	A gas turbine engine fan stage 10 has a rotor comprising blades 12 circumscribed by a case 42 that forms a fan duct (Figs. 1 and 2; col. 2, lines 42-44 and 56-58).
a fan casing having an inner duct wall which in a fan rotor region is convergent in the downstream direction; and	The case 42 has an inlet region in which the fan rotor is disposed and an inner wall that converges in the downstream direction (Figs. 1 and 2; col. 3, lines 58-67).

a fan rotor including a multiplicity of swept fan blades spaced apart around a hub mounted concentrically with respect to the fan duct, each of said swept fan blades having	The fan blades 12 are spaced apart around a hub 16, 20. The hub and case have the same centerline 18 and thus are concentric (Figs. 1 and 2; col. 2, lines 42-63). The blades are swept (col. 4, lines 11-17 and 24-29).
a tip profile which in revolution substantially corresponds to the convergent duct wall,	A blade 12, seen in Fig. 2 projected into the radial plane of the drawing (that is, "in revolution"), has a tip profile that corresponds to the inner wall of the case 42 (Figs. 1 and 2; col. 3, lines 26-29).
a leading edge of variable sweep angle which varies with increasing blade height or distance from the axis of rotation, said sweep angle having	The blade leading edge 28 has an intermediate region 70 with a sweep angle σ_1 and a tip region 74 with a sweep angle σ_2, both of which vary with increasing blade height (Fig. 2; col. 4, lines 11-17 and lines 24-29).
a forward sweep angle in a first height region between the root and a first intermediate radius,	A first height region between the blade root 24 (that is, adjacent the hub 16, 20) and $r_{t\text{-inner}}$ is swept forward (Fig. 2; col. 5, lines 55-58).
a rearward sweep angle in an intermediate height region between the first intermediate radius and a second intermediate radius,	The intermediate region 70 between $r_{t\text{-inner}}$ and $r_{t\text{-outer}}$ is swept rearward (Figs. 1 and 2; col. 4, lines 11-13).
a sweep angle in a third height region between the second intermediate radius and the tip of the blade such that the third height region is translated forward relative to the leading edge at the second intermediate radius,	The tip region 74 between $r_{t\text{-outer}}$ and the blade tip 26 is translated axially forward relative to a conventional blade (col. 4, line 62, to col. 5, line 5).
a stagger angle which increases progressively with blade height.	Any fan blade inherently has a stagger angle that progressively increases with blade height because the blade's velocity U in the tangential direction increases with blade height while the axial flow velocity V_x remains constant with blade height (Fig. 3; col. 3, lines 3-6; see also Schwaar Fig. 2 and col. 3, line 66, to col. 4, line 21).

(2) Dependent Claims 11 And 13-17

Dependent claim 11 is based closely on dependent claim 2 of the Rolls '077 Patent. It reads as follows:

A fan stage of a ducted fan gas turbine engine as claimed in claim 10 characterized in that the stagger angle increases to less than 90° at the tip relative to the airflow direction.

The recitation of a stagger angle at the tip of less than 90° at the tip relative to the airflow direction is clearly shown in Fig. 3 of the present application. Referring back to Fig. 2, it is seen that Fig. 3 is a view radially inward from the blade tip 26. The blade clearly has a stagger angle less than 90° relative to the axial velocity vector V_x of the working medium (Fig. 3).

Dependent claim 13 is a variant of dependent claim 3 of the Rolls '077 Patent. It reads as follows:

A fan stage of a ducted fan gas turbine engine as claimed in claim 11 wherein in a blade tip region the sweep of the leading edge decreases.

This claim is supported by Fig. 2 of the present application, which shows that the sweep angle decreases in the translated-forward outermost region of the blade. See also col. 4, lines 26-29.

Dependent claim 14 is based closely on dependent claim 4 of the Rolls '077 Patent. It reads as follows:

A fan stage of a ducted fan gas turbine engine as claimed in claim 13 wherein the blade is further characterized in that the stagger angle of the mid-height region of the blade is a predetermined fraction of the stagger angle at the tip region.

As noted above, the fan blade 12 inherently has a stagger angle that progressively increases with blade height as a necessary consequence of the progressive increase in the blade's velocity U in the tangential direction while the axial flow velocity V_x remains constant. Accordingly, the stagger angle at a mid-height region of the blade inherently is a predetermined fraction of the stagger angle at the tip region.

Dependent claim 15 is identical to dependent claim 5 of the Rolls '077 Patent. It reads as follows:

> A fan stage of a ducted fan gas turbine engine as claimed in claim 10 wherein the sweep angle of the leading edge of a swept fan blade at a point on the leading edge is less than the complement of the angle of a Mach cone at any other point on the leading edge of the blade at greater radius from the root.

As discussed above in connection with Rolls claim 5, this claim relates to known principles, under which it is clear that the present application inherently discloses the subject matter of this claim. One of the reasons for using the blade configuration recited in the claims of the present application is to account for the *presence* of shock waves in the flow over the blade. Accordingly, the leading edge of the blades disclosed in the present application is not swept sufficiently to eliminate those shock waves, which is exactly what is recited in UTC claim 15 (and Rolls claim 5). Put another way, if the leading edge of the present application's blade 12 were swept sufficiently to eliminate shock waves, there would be no shock waves 64, 66 as depicted in Fig. 3 and discussed in the application text at column 4, lines 33-62.

Dependent claim 16 is identical to dependent claim 6 of the Rolls '077 Patent. It reads as follows:

> A fan stage of a ducted fan gas turbine engine as claimed in claim 10 wherein the shape of the pressure surface of a swept fan blade and the suction surface thereof creates, in use, a line of minimum static pressure points on the suction surface of the blade, said line of minimum static pressure points is inclined with respect to the axial direction at a sweep angle which varies with span height of the blade, and has a negative value in a region of subsonic flow over the leading edge.

This claim also does no more than recite inherent features of the blade disclosed in the present application. It will be appreciated immediately that by definition a gas turbine engine fan blade is an airfoil with a suction surface and a pressure surface. Accordingly, at each location along the blade height, the suction surface will have a minimum static pressure point. The locus of those points will, again by definition, be a line of minimum static pressure points. As discussed above in connection with Rolls claim 6, the line of minimum static pressure points is

inherently inclined at a sweep angle that varies with the blade height, and that sweep angle will inherently be negative in the inner, subsonic-flow region of the blade.

Dependent claim 17 is identical to dependent claim 7 of the Rolls '077 Patent. It reads as follows:

> A fan stage of a ducted fan gas turbine engine as claimed in claim 16 wherein the sweep angle of the line of minimum static pressure points at a point on the line is less than the complement of a Mach cone angle at any other point on the line.

This claim relates to the same concept as claim 15. This subject matter is inherently disclosed in the present application by the same reasoning discussed above in connection with Rolls claim 7

(3) Independent Claim 18

Independent claim 18 is based closely on claim 8 of the Rolls '077 Patent. The following claim chart applies the terms of claim 18 to the disclosure in the present application.

Present Application Claim 18	Present Application Disclosure
A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:	A gas turbine engine fan stage 10 has blades 12 circumscribed by a case 42 that forms a fan duct (Figs. 1 and 2; col. 2, lines 42-44 and 56-58). The fan is rotatable about an axis 18 (Fig. 2, col. 2, lines 44-46).
a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region being convergent;	The case 42 has an inlet region in which the fan is disposed and an inner wall that converges in the downstream direction (Figs. 1 and 2; col. 3, lines 58-67).
a hub disposed concentrically relative to the fan casing;	The hub 16, 20 and case 42 have the same centerline 18 and thus are concentric (Figs. 1 and 2; col. 2, lines 42-63).
a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:	The fan blades 12 are spaced apart around the hub. The blades are swept (col. 4, lines 11-17 and 24-29).

a tip profile that substantially corresponds to the convergent inner duct wall of the fan casing;	The blade 12, seen in Fig. 2 projected into the radial plane of the drawing, has a tip profile that corresponds to the inner wall of the case 42 (Figs. 1 and 2; col. 3, lines 26-29).
a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:	The blade leading edge 28 has an intermediate region 70 with a sweep angle σ_1 and a tip region 74 with a sweep angle σ_2, both of which vary with increasing blade height (Fig. 2; col. 4, lines 11-17 and lines 24-29).
an inner region adjacent the hub, the inner region defining a forward sweep angle;	A first height region between the blade root 24 (that is, adjacent the hub 16,20) and $r_{t\text{-}inner}$ is swept forward (Fig. 2; col. 5, lines 55-58).
an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and	The intermediate region 70 between $r_{t\text{-}inner}$ and $r_{t\text{-}outer}$ is swept rearward (Figs. 1 and 2; col. 4, lines 11-13).
an outer region between the intermediate region and the fan casing, the outer region being translated forward relative to the leading edge at an outward boundary of the intermediate region.	The tip region 74 between $r_{t\text{-}outer}$ and the blade tip 26 is translated axially forward relative to a conventional blade (col. 4, line 62, to col. 5, line 5).

(4) Dependent Claims 19, 20, And 22

Dependent claim 19 is identical to dependent claim 9 of the Rolls '077 Patent. It reads as follows:

> The fan stage according to claim 18, wherein the intermediate region extends further than the inner region along the axis of rotation.

Fig. 2 of the present application clearly demonstrates that it discloses the subject matter of this claim. That is, Fig. 2, being a projection of the blade onto the plane of the figure, col. 3, lines 26-29, shows the blade at $r_{t\text{-}inner}$ extending further along the axis 18 than the region inward thereof.

Dependent claim 20 is identical to dependent claim 10 of the Rolls '077 Patent. It reads as follows:

The fan stage according to claim 18, wherein the inner duct wall of the fan casing at the fan rotor region is substantially convergent in the downstream direction.

Figs. 1 and 2 of the present application disclose the subject matter of claim 20.

Dependent claim 22 is identical to dependent claim 13 of the Rolls '077 Patent. It reads as follows:

The fan stage according to claim 18, wherein each of the multiple swept fan blades includes a hub contacting surface that extends further than the tip profile along the axis of rotation.

Fig. 2 of the present application shows that the blade's hub contacting surface at the root 24 extends further along the axis 18 than at the blade tip 26.

(5) Independent Claim 23

Independent claim 23 is also based closely on claim 8 of the Rolls '077 Patent. The following claim chart applies the terms of claim 23 to the disclosure in the present application.

Present Application Claim 23	Present Application Disclosure
A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:	A gas turbine engine fan stage 10 has blades 12 circumscribed by a case 42 that forms a fan duct (Figs. 1 and 2; col. 2, lines 42-44 and 56-58). The fan is rotatable about an axis 18 (Fig. 2, col. 2, lines 44-46).
a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region being convergent;	The case 42 has an inlet region in which the fan is disposed, and an inner wall that converges in the downstream direction (Figs. 1 and 2; col. 3, lines 58-67).
a hub disposed concentrically relative to the fan casing;	The hub 16, 20 and case 42 have the same centerline 18 and thus are concentric (Figs. 1 and 2; col. 2, lines 42-63).
a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub and being capable of rotating at speeds providing supersonic working medium gas velocities over the blades to cause a shock in the gas adjacent the inner duct wall, each of the multiple swept fan blades having:	The fan blades 12 are spaced apart around the hub. The blades are swept (col. 4, lines 11-17 and 24-29). The blades rotate at speeds high enough to experience supersonic velocities near their tips, and a shock 64 forms adjacent the inner duct wall (Fig. 2; col. 3, lines 30-40).

a tip profile that substantially corresponds to the convergent inner duct wall of the fan casing;	The blade 12, seen in Fig. 2 projected into the radial plane of the drawing, has a tip profile that corresponds to the inner wall of the case 42 (Figs. 1 and 2; col. 3, lines 26-29).
a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:	The blade leading edge 28 has an intermediate region 70 with a sweep angle σ_1 and a tip region 74 with a sweep angle σ_2, both of which vary with increasing blade height (Fig. 2; col. 4, lines 11-17 and lines 24-29).
an inner region adjacent the hub, the inner region defining a forward sweep angle;	A first height region between the blade root 24 (that is, adjacent the hub 16,20) and $r_{t\text{-inner}}$ is swept forward (Fig. 2; col. 5, lines 55-58).
an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and	The intermediate region 70 between $r_{t\text{-inner}}$ and $r_{t\text{-outer}}$ is swept rearward (Figs. 1 and 2; col. 4, lines 11-13).
an outer region between the intermediate region and the fan casing, the outer region being translated forward relative to the leading edge at an outward boundary of the intermediate region to provide a sweep angle that causes the blade to intercept the shock.	The tip region 74 between $r_{t\text{-outer}}$ and the blade tip 26 is translated axially forward relative to a conventional blade to intercept the shock (col. 4, line 62, to col. 5, line 5).

Accordingly, all of UTC's reissue claims 10, 11, 13-20, 22, and 23 are supported by the present application (and the Original UTC Application) in accordance with 35 U.S.C. § 112, first paragraph.

f. 37 C.F.R. § 1.607(a)(6) -- The Requirements of 35 U.S.C. § 135(b) Are Met

Claims identical to those in the Rolls '077 Patent were present in this application when it was filed on June 5, 2001, which was prior to one year from issuance of the Rolls '077 Patent on June 6, 2000. Accordingly, the applicants' claims on which this request for interference is based were timely presented under 35 U.S.C. § 135(b).

SUMMARY OF INTERFERENCE

UTC requests that an interference be declared as follows.

Parties

Junior Party: Rolls-Royce PLC
Senior Party: United Technologies Corporation

Count 1

UTC claim 18 or Rolls claim 8.

Designated Claims

UTC claims 10, 11, 13-20, 22, and 23 (all pending application claims)
Rolls claims 1-13 (all patent claims)

Effective filing dates

UTC: Nov. 17, 1995
Rolls: Oct. 9, 1998

INFORMATION DISCLOSURE STATEMENT

The great majority of the documents listed on the enclosed Form PTO-1449 were of record in the UTC Parent Reissue Application, on which the present application relies for an earlier effective filing date under 35 U.S.C. § 120. The citation of this information in that earlier application was in accord with 37 C.F.R. § 1.97(a) and (c), and the information was considered by the Examiner. Accordingly, consideration of the information in the present application pursuant to 37 C.F.R. § 1.97(d) is respectfully requested. Except as specifically noted above, copies of the listed documents are not enclosed, but the applicants will provide the Examiner with copies of any other listed document upon request.

Other than Stewart, the only newly listed documents are the EPO Official Action in EP 801,230 (the European counterpart of the Rolls '077 Patent) and U.S. Patent 4,274,810, cited in that Official Action. Copies of those two documents are enclosed.

CONCLUSION

The Examiner is requested to forward the present reissue application to the Board of Patent Appeals and Interferences pursuant to 37 C.F.R. § 1.609(a), with a statement identifying the particulars of an interference with the Rolls '077 Patent in accordance with the above Request for an Interference. To assist the Examiner in preparing the application for the requested interference, a completed Form PTO-850 and accompanying Interference Initial Memorandum, with which the Examiner can forward the application to the Board, are attached as Exhibit D.

The applicants have attempted to place the present application in condition for declaration of an interference. However, the applicants are presenting this Supplemental Preliminary Amendment, Information Disclosure Statement, and Request for An Interference with a formal Request for Early Examiner Interview in order to discuss any questions the Examiner may have concerning the present case and to expedite forwarding of the application to the Board for declaration of the requested interference.

Any fees due on account of this paper may be charged to Deposit Account No. 50-0409.

All correspondence should continue to be sent to the attorney named below at the address shown.

Respectfully submitted,

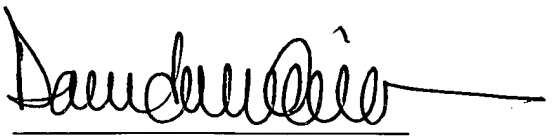

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EXHIBIT A

10. (Amended) A fan stage of a ducted fan gas turbine engine, comprising

a fan casing having an inner duct wall which in a fan rotor region is convergent in the downstream direction; and

a fan rotor including a multiplicity of swept fan blades spaced apart around a hub mounted concentrically with respect to the fan duct, each of said swept fan blades having a tip profile which in revolution [is convergent so as to] substantially corresponds to the convergent duct wall, a leading edge of variable sweep angle which varies with increasing blade height or distance from the axis of rotation, said sweep angle having a forward sweep angle in a first height region between the root and a first intermediate radius, a rearward sweep angle in an intermediate height region between the first intermediate radius and a second intermediate radius, a [forward] sweep angle in a third height region between the second intermediate radius and the tip of the blade such that the third height region is translated forward relative to the leading edge at the second intermediate radius, a stagger angle which increases progressively with blade height.

11. (Amended) A fan stage of a ducted fan gas turbine engine as claimed in claim 10 [wherein the blade has a tip region of up to about 24% of blade height] characterized in that the stagger angle increases to less than 90° at the tip relative to the airflow direction.

13. (Amended) A fan stage of a ducted fan gas turbine engine as claimed in claim 11 wherein in a blade tip region [of about 24% of the height of the blade] the sweep of the leading edge decreases.

14. (As Filed) A fan stage of a ducted fan gas turbine engine as claimed in claim 13 wherein the blade is further characterized in that the stagger angle of the mid-height region of the blade is a predetermined fraction of the stagger angle at the tip region.

15. (As Filed) A fan stage of a ducted fan gas turbine engine as claimed in claim 10 wherein the sweep angle of the leading edge of a swept fan blade at a point on the leading edge is less than the complement of the angle of a Mach cone at any other point on the leading edge of the blade at greater radius from the root.

16. (As Filed) A fan stage of a ducted fan gas turbine engine as claimed in claim 10 wherein the shape of the pressure surface of a swept fan blade and the suction surface thereof creates, in use, a line of minimum static pressure points on the suction surface of the blade, said line of minimum static pressure points is inclined with respect to the axial direction at a sweep angle which varies with span height of the blade, and has a negative value in a region of subsonic flow over the leading edge.

17. (As Filed) A fan stage of a ducted fan gas turbine engine as claimed in claim 16 wherein the sweep angle of the line of minimum pressure points at a point on the line is less than the complement of the angle of a Mach cone at any other point on the line.

18. (Amended) A fan stage of a ducted <u>fan</u> gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:

a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region being convergent;

a hub disposed concentrically relative to the fan casing;

a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:

a tip profile that [is convergent so as to] substantially corresponds to the convergent inner duct wall of the fan casing;

a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:

an inner region adjacent the hub, the inner region defining a forward sweep angle;

an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and

an outer region between the intermediate region and the fan casing, the outer region being translated forward relative to the leading edge at an outward boundary of the intermediate region [defining a forward sweep angle].

19. (As Filed) The fan stage according to claim 18, wherein the intermediate region extends further than the inner region along the axis of rotation.

20. (As Filed) The fan stage according to claim 18, wherein the inner duct wall of the fan casing at the fan rotor region is substantially convergent in the downstream direction.

22. (As Filed) The fan stage according to claim 18, wherein each of the multiple swept fan blades includes a hub contacting surface that extends further than the tip profile along the axis of rotation.

23. (New) A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:

a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region being convergent;

a hub disposed concentrically relative to the fan casing;

a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub and being capable of rotating at speeds providing supersonic working medium gas velocities over the blades to cause a shock in the gas adjacent the inner duct wall, each of the multiple swept fan blades having:

a tip profile that substantially corresponds to the convergent inner duct wall of the fan casing;

a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:

an inner region adjacent the hub, the inner region defining a forward sweep angle;

an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and

an outer region between the intermediate region and the fan casing, the outer region being translated forward relative to the leading edge at an outward boundary of the intermediate region to provide a sweep angle that causes the blade to intercept the shock.

EXHIBIT B

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/168,968	10/09/98	ROWLANDS P	JAO-3940m

QM02/0818

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EXAMINER
KWON, J

ART UNIT	PAPER NUMBER
3747	7

DATE MAILED: 08/16/99

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary	Application No. 09/168,968	Applicant(s) Paul A. Rowlands
	Examiner John T. Kwon	Group Art Unit 3747

☐ Responsive to communication(s) filed on _____.

☐ This action is **FINAL**.

☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire 3 month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) 1-7 is/are pending in the application.

Of the above, claim(s) _____ is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) 1-7 is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☐ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on _____ is ☐approved ☐disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☒ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☒ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☒ received in Application No. (Series Code/Serial Number) 08/819,269.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____.

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☒ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). 5

☐ Interview Summary, PTO-413

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- *SEE OFFICE ACTION ON THE FOLLOWING PAGES* ---

DETAILED ACTION

Housekeeping

Applicant(s) is(are) suggested to list a current telephone number, a facsimile number and a list of the attachments, if any, under the signature of the attorney/applicant for each response to the Office action(s) in order to expedite and make accurate the prosecution of the application.

1. The submission of the Information Disclosure Statement dated October 9, 1998 has been received and fully considered. No further Information Disclosure Statement is in the records.

2. Applicants are advised to insert the current status of the parent application S.N. 08/819,269.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless --
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

4. Claims 1 and 5-7 are rejected under 35 U.S.C. 102(b) as being clearly anticipated by Spear (US 5,642,985)*. Spear disclose a leading edge inclined with respect to the axial direction by the sweep angle in a rotor blade. A sweep angle is provided a positive value between a root and a first intermediate radius, a negative value between the first intermediate radius and a second radius, and a positive value between the second intermediate radius and a tip of the blade.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 2-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Spear (US 5,642,985)*. Spear disclose a leading edge inclined with respect to the axial direction by the sweep angle in a rotor blade. A sweep angle is provided a positive value between a root and a first intermediate radius, a negative value between the first intermediate radius and a second radius, and a positive value between the second intermediate radius and a tip of the blade. The difference between the prior art reference and the instant invention are the particular dimensional relationship between the regions and the stagger angle. It would have been considered to be an obvious choice of mechanical design because one skilled in this art is familiar with basic fluid mechanic and normally has the laboratory test facilities. To optimize or select the suitable dimensional relationship between the regions and the stagger angle would be within the ability of ordinary skilled in this art.

Contact Information

Any inquiry concerning this communication should be directed to Examiner Kwon at telephone number (703) 308-1046 and facsimile numbers (703) 305-3588. The examiner can normally be reached on Monday thru Friday from 8:30 AM to 5:00 PM.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0861.

John T. Kwon
Primary Examiner
Art Unit 3747

August 13, 1999
Enclosure(s);
See the attachment(s) section of the Office Action Summary.

Notice of References Cited

Application No.	Applicant(s)		
09/168,968	Paul A. Rowlands		
Examiner		Group Art Unit	Page 1 of 1
John T. Kwon		3747	

U.S. PATENT DOCUMENTS

	DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS
A	NONE			----	----
B					
C					
D					
E					
F					
G					
H I J					
K					
L					
M					

FOREIGN PATENT DOCUMENTS

	DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUBCLASS
N	NONE				----	
O P						
Q						
R						
S						
T						

NON-PATENT DOCUMENTS

	DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
U		
V		
W		
X		

Form PTO-1449 (REV. 8-83) — U.S. Department of Commerce PATENT AND TRADEMARK OFFICE

INFORMATION DISCLOSURE STATEMENT

(Use several sheets if necessary)

ATTY DOCKET NO.	APPLICATION NO.
JAO 39406A	~~New U.S. Continuation-In-Part Application of~~ Application No. 08/819,269
APPLICANT: Paul A. ROWLANDS	09/168,968
FILING DATE: 10/9/98	GROUP: 3747

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB CLASS
AK		5,064,345	11/91	KIMBALL	—	—
		4,488,399	12/84	ROBEY, et al.		
		4,358,246	11/82	HANSON et al.		
		5,642,985	7/97	SPEAR et al.		
		3,989,406	11/76	BLISS		
		4,726,737	2/88	WEINGOLD et al.		
AK		4,790,724	12/88	BOUSQUET et al.	—	—

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUB CLASS
AK		GB 2-197-913	6/88	GREAT BRITAIN	—	—
		GB 2-170-868	8/86	GREAT BRITAIN		
		GB 2-104-975	3/83	GREAT BRITAIN		
		EP-A-0 385 913	9/90	EUROPE		
AK		WO 81/00243	2/81	WIPO	—	—

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, etc.)

EXAMINER	DATE CONSIDERED
KWON	8/13/99

Examiner: Initial if citation considered, whether or not citation is in conformance with M.P.E.P. 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Form PTO-1449 (REV. 8-83)	US Dept. of Commerce PATENT AND TRADEMARK OFFICE	ATTY DOCKET NO. JAO 39406A	APPLICATION NO. ~~New U.S. Continuation-In-Part Application of Application No. 08/819,269~~ 09/168,968
INFORMATION DISCLOSURE STATEMENT (Use several sheets if necessary)		APPLICANT Paul A. ROWLANDS	
		FILING DATE 10/9/98	GROUP 3747

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB CLASS
JK	/	5,249,922	10/93	SATO et al.	—	—

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUB CLASS
JK	/	EP-A-0 266 298	5/88	EUROPE	—	—
JK	/	EP-A-0265335	4/88	EUROPE	—	—

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, etc.)

EXAMINER	KWON	DATE CONSIDERED 8/13/99

Examiner: Initial if citation considered, whether or not citation is in conformance with M.P.E.P. 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Paul A. ROWLANDS

Application No.: 09/168,968

Filed: October 9, 1998

For: SWEPT FAN BLADE

Group Art Unit: 3747

Examiner: J. Kwon

Docket No.: JAO 39406A

AMENDMENT UNDER 37 C.F.R. §1.111

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

In response to the Office Action mailed August 18, 1999, please amend the above-identified application as follows:

IN THE SPECIFICATION:

Please amend the specification as follows:

Page 1, before the first line, after "1997" insert --, now abandoned--.

IN THE CLAIMS:

Please add claims 8-13 as follows:

subc 2

--8. A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:

a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region extending at an angle relative to the axis of rotation;

a hub disposed concentrically relative to the fan casing

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a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:

a tip profile that extends at an angle relative to the axis of rotation;

a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:

an inner region adjacent the hub, the inner region defining a forward sweep angle;

an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and

an outer region between the intermediate region and the fan casing, the outer region defining a forward sweep angle.--

--9. The fan stage according to claim 8, wherein the intermediate region extends further than the inner region along the axis of rotation.--

--10. The fan stage according to claim 8, wherein the inner duct wall of the fan casing at the fan rotor region is substantially convergent in the downstream direction.--

--11. The fan stage according to claim 8, wherein the tip profile of the multiple swept fan blades are substantially convergent in the downstream direction.--

--12. The fan stage according to claim 8, wherein the inner duct wall of the fan casing at the fan region is not parallel to the tip profile of each of the multiple swept fan blades.--

--13. The fan stage according to claim 8, wherein each of the multiple swept fan blades includes a hub contacting surface that extends further than the tip profile along the axis of rotation.--

REMARKS

Claims 1-13 are pending. By this Amendment, the specification is amended, and claims 8-13 are added. Reconsideration in view of the above amendments and following remarks is respectfully requested.

The Office Action requests that the specification be amended to indicate the current status of the parent application. The specification is amended to indicate that the parent application is abandoned.

I. CLAIMS 1-7 DEFINE ALLOWABLE SUBJECT MATTER

The Office Action rejects claims 1 and 5-7 under 35 U.S.C. §102(b) as unpatentable over U.S. Patent No. 5,642,985 to Spear et al. (hereinafter "the 985 patent"); and claims 2-4 under 35 U.S.C. §103 as unpatentable over the 985 patent. The rejections are respectfully traversed.

The 985 patent does not disclose a fan stage of a ducted fan gas turbine engine comprising a fan casing having an inner duct wall which in the region of a fan rotor is convergent in the downstream direction, a fan rotor comprising a multiplicity of swept fan blades spaced apart around a hub mounted concentrically with respect to the fan duct, each of said swept fan blades having a tip profile which in revolution conforms to the convergent duct wall, as claimed in claim 1.

Instead, Figs. 1, 2 and 6 of the 985 patent show that the inner surface of the case 42 is substantially parallel to the rotational axis 18 and shaft 52.

In fact, the specification distinguishes the invention from the 985 patent. For example, the specification indicates at page 10, lines 6-18, as follows:

> The inner surface of the annular fan casing in the region 17 immediately encircling the fan rotor is tapered in the downstream direction, that is the diameter of the region 17 is greater on the upstream side of the fan 1 compared to the downstream side. Generally it has the appearance of a short frusto-conical surface although to avoid aerodynamic

turbulence abrupt contour changes are avoided and blended smoothly with the remaining inner surface of the casing. An angled casing of this kind has long been used by us to avoid complicated aerodynamic interference effects which might otherwise be brought about by reflection of the passage shock waves from the casing wall as has been described in U.S. Patent No. 5,642,985. In the present invention the potential effect of reflected passage shock waves is lessened by the reduction of airspeed in the blade tip regions which naturally produces weaker shock waves. Thus, any proclivity to generation of a reflected endwall shock is further reduced by the effect of the blade design.

For at least these reasons, it is respectfully submitted that claim 1 is distinguishable over the applied art. Claims 2-7, which depend from claim 1, are likewise distinguishable over the applied art for at least the reasons discussed as well as for the additional features they recite. Withdrawal of the rejections under 35 U.S.C. §102 and §103 is respectfully requested.

II. CONCLUSION

In view of the foregoing remarks, Applicant respectfully submits that this application is in condition for allowance. Favorable consideration and prompt allowance are earnestly solicited.

Should the Examiner believe anything further is desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact Applicant's undersigned representative at the telephone number listed below.

Respectfully submitted,

James A. Oliff
Registration No. 27,075

Eric D. Morehouse
Registration No. 38,565

JAO:EDM/ccs

OLIFF & BERRIDGE, PLC
P.O. Box 19928
Alexandria, Virginia 22320
Telephone: (703) 836-6400

Interview Summary

Application No.	Applicant(s)	
09/168,968	Paul A. Rowlands	
Examiner	Group Art Unit	
John T. Kwon	3747	

All participants (applicant, applicant's representative, PTO personnel):

(1) *John T. Kwon* (3) *Mr. Billings*

(2) *Mr. Morehouse* (4)

Date of Interview *Nov 19, 1999*

Type: ☐ Telephonic ☒ Personal (copy is given to ☐ applicant ☒ applicant's representative).

Exhibit shown or demonstration conducted: ☐ Yes ☒ No. If yes, brief description:

Agreement ☒ was reached. ☐ was not reached.

Claim(s) discussed: *claims 1-13*

Identification of prior art discussed:
Spear (US 5,642,985)

Description of the general nature of what was agreed to if an agreement was reached, or any other comments:
The attorneys were suggested to insert the structural limitation such as the inner portion of the casing has a corresponding shape as the convergent tip portion of the blade in order to overcome the previous office action.

(A fuller description, if necessary, and a copy of the amendments, if available, which the examiner agreed would render the claims allowable must be attached. Also, where no copy of the amendents which would render the claims allowable is available, a summary thereof must be attached.)

1. X It is not necessary for applicant to provide a separate record of the substance of the interview.

Unless the paragraph above has been checked to indicate to the contrary, A FORMAL WRITTEN RESPONSE TO THE LAST OFFICE ACTION IS NOT WAIVED AND MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a response to the last Office action has already been filed, APPLICANT IS GIVEN ONE MONTH FROM THIS INTERVIEW DATE TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW.

2. ☐ Since the Examiner's interview summary above (including any attachments) reflects a complete response to each of the objections, rejections and requirements that may be present in the last Office action, and since the claims are now allowable, this completed form is considered to fulfill the response requirements of the last Office action. Applicant is not relieved from providing a separate record of the interview unless box 1 above is also checked.

JOHN T. KWON
PRIMARY EXAMINER
ART UNIT 3747

Examiner Note: You must sign and stamp this form unless it is an attachment to a signed Office action.

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Paul A. ROWLANDS

Application No.: 09/168,968

Filed: October 9, 1998

For: SWEPT FAN BLADE

Group Art Unit: 3747

Examiner: J. Kwon

Docket No.: JAO 39406A

SUPPLEMENTAL AMENDMENT UNDER 37 C.F.R. §1.115

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Further to the November 10 Amendment under 37 C.F.R. §1.111 and the November 19 personal interview with Examiner Kwon, please amend the above-identified application as follows:

IN THE CLAIMS:

Please amend claims 1 and 8 as follows:

1. (Amended) A fan stage of a ducted fan gas turbine engine, comprising:

a fan casing having an inner duct wall which in [the] a fan rotor region [of a fan rotor] is convergent in the downstream direction; and[,]

a fan rotor [comprising] including a multiplicity of swept fan blades spaced apart around a hub mounted concentrically with respect to the fan duct, each of said swept fan blades having a tip profile which in revolution [conforms] is convergent so as to substantially correspond to the convergent duct wall, a leading edge of variable sweep angle which varies with increasing blade height or distance from the axis of rotation, said sweep angle having a forward

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sweep angle in a first height region between the root and a first intermediate radius, a rearward sweep angle in an intermediate height region between the first intermediate radius and a second intermediate radius, a forward sweep angle in a third height region between the second intermediate radius and the tip of the blade, a stagger angle which increases progressively with blade height.

C1

8. (Amended) A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:

a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region [extending at an angle relative to the axis of rotation] being convergent;

C2

a hub disposed concentrically relative to the fan casing;

a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:

a tip profile that [extends at an angle relative to the axis of rotation] is convergent so as to substantially correspond to the convergent inner duct wall of the fan casing;

a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:

an inner region adjacent the hub, the inner region defining a forward sweep angle;

an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and

an outer region between the intermediate region and the fan casing, the outer region defining a forward sweep angle.

REMARKS

Claims 1-13 are pending. By this Amendment, claims 1 and 8 are amended. Reconsideration in view of the above amendments and following remarks is respectfully requested.

Applicant gratefully appreciates the courteous extended to Applicant's representative by Examiner Kwon in the November 19 personal interview. The points discussed are incorporated into the following remarks.

During the personal interview, Examiner Kwon discussed claim amendments to clarify the invention and place the application in condition for allowance. Claims 1 and 8 are amended accordingly.

In view of the foregoing remarks, Applicant respectfully submits that this application is in condition for allowance. Favorable consideration and prompt allowance are earnestly solicited.

Should the Examiner believe anything further is desirable to place the application in even better condition for allowance, the Examiner is invited to contact Applicant's undersigned attorney at the telephone number listed below.

Respectfully submitted,

James A. Oliff
Registration No. 27,075

Eric D. Morehouse
Registration No. 38,565

JAO:EDM/ccs

OLIFF & BERRIDGE, PLC
P.O. Box 19928
Alexandria, Virginia 22320
Telephone: (703) 836-6400

EXHIBIT C

Proposed Count 1

Alternate Count 1(a) -- UTC Claim 18

A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:

a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region being convergent:

a hub disposed concentrically relative to the fan casing;

a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:

a tip profile that substantially corresponds to the convergent inner duct wall of the fan casing;

a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:

an inner region adjacent the hub, the inner region defining a forward sweep angle;

an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and

an outer region between the intermediate region and the fan casing, the outer region being translated forward relative to the leading edge at an outward boundary of the intermediate region.

OR

Alternate Count 1(b) -- Rolls Claim 8

A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:

a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region being convergent:

a hub disposed concentrically relative to the fan casing;

a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:

a tip profile that is convergent so as to substantially corresponds to the convergent inner duct wall of the fan casing;

a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:

an inner region adjacent the hub, the inner region defining a forward sweep angle;

an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and

an outer region between the intermediate region and the fan casing, the outer region defining a forward sweep angle.

EXHIBIT D

INTERFERENCE INITIAL MEMORANDUM

BOARD OF PATENT APPEALS AND INTERFERENCES: An interference is found to exist between the following cases:

This interference involves 2 parties

PARTY	APPLICATION NO.	FILING DATE	PATENT NO., IF ANY	ISSUE DATE, IF ANY
Spear et al.	09/874,931	June 5, 2001		

If application has been patented, have maintenance fees been paid? _____Yes _____No __X__ Maintenance fees not due yet

**Accorded the benefit of:

COUNTRY	APPLICATION NO.	FILING DATE	PATENT NO., IF ANY	ISSUE DATE, IF ANY
United States	09/343,736	June 30, 1999		
United States	08/559,965	November 17, 1995	5,642,985	July 1, 1997

The claim(s) of this party which correspond(s) to this count is (are): **PATENTED OR PATENTABLE PENDING CLAIMS** 10, 11, 13-20, 22, and 23	**UNPATENTABLE PENDING CLAIMS** None
The claim(s) of this party which does (do) not correspond(s) to this count is (are): **PATENTED OR PATENTABLE PENDING CLAIMS** None	**UNPATENTABLE PENDING CLAIMS** None

PARTY	APPLICATION NO.	FILING DATE	PATENT NO., IF ANY	ISSUE DATE, IF ANY
Rowlands	09/168,968	October 9, 1998	6,071,077	June 6, 2000

If application has been patented, have maintenance fees been paid? _____Yes _____No __X__ Maintenance fees not due yet

**Accorded the benefit of:

COUNTRY	APPLICATION NO.	FILING DATE	PATENT NO., IF ANY	ISSUE DATE, IF ANY

The claim(s) of this party which correspond(s) to this count is (are): **PATENTED OR PATENTABLE PENDING CLAIMS** 1-13	**UNPATENTABLE PENDING CLAIMS** Does not apply
The claim(s) of this party which does (do) not correspond(s) to this count is (are): **PATENTED OR PATENTABLE PENDING CLAIMS** None	**UNPATENTABLE PENDING CLAIMS** Does not apply

Instructions

1. For every patent involved in the interference, check if the maintenance fees have been paid by using the patent number with PALM screen 2970. If fees are due and they have not been paid, the interference cannot be declared since it would involve an expired patent. (35 U.S.C. 135(a); 37 CFR 1.606).
2. For each party, separately identify the patentable and unpatentable claims which correspond to the count. (37 CFR 1.601(f), 1.601(n), 1.609(b)(2)).
3. For each party, separately identify the patentable and unpatentable claims which do not correspond to the count (37 CFR 1.609(b)(3)).
4. Forward all files including those the benefit of which is being accorded.
5. Keep a copy of the Interference Initial Memorandum and any attachments for your records.

All information requested below must be attached on (a) separate typewritten sheet(s)

6. On a separate sheet, set forth a single proposed interference count. If any claim or any party is exactly the same word for word as this count, please indicate the party, application or patent number, and the claim number.
7. For each claim designated as corresponding to the count, provide an explanation of why each claim defines the same patentable invention as the count (37 CFR 1.609(b)(2)).
8. For each claim designated as not corresponding to the count, provide an explanation of why each claim defines a separate patentable invention from the count (37 CFR 1.609(b)(3)).
9. For each additional count, if any, repeat steps 2-6 and, additionally, provide an explanation why each count represents a separate patentable invention from every other count (37 CFR 1.609(b)(1)).

DATE	PRIMARY EXAMINER (Signature)	TELEPHONE NO.	ART UNIT
	Christopher Verdier	703-308-2638	3745
DATE	GROUP DIRECTOR SIGNATURE (If required)		

**The application number and filing date of each application the benefit of which is intended to be accorded must be listed. It is not sufficient to merely list the earliest application if there are intervening applications necessary for continuity.

THIS PAGE CAN BE DUPLICATED IF THERE ARE MORE THAN TWO INTERFERING PARTIES.

COUNT

Claim 18 of Application No. 09/874,931 (Alternate A)

OR

Claim 8 of Patent No. 6,071,077 (Alternate B)

Claim 18 of Application No. 09/874,931 (Alternate A) and claim 8 of Patent No. 6,071,077 (Alternate B) Define the Same Patentable Invention

The Count is patentable over the prior art of record because the prior art fails to show a ducted fan gas turbine engine fan blade having a leading edge that, in a direction outward from the fan axis of rotation, has an inner region with a forward sweep angle, an intermediate region having a rearward sweep angle, and an outer region translated forward relative to the leading edge at an outward boundary of the intermediate region so as to have a decreased sweep angle. The closest prior art of record is represented by fan blades such as those shown in U.S. Patents No. 4,012,172 to Schwaar et al. and No. 4,726,737 to Weingold et al. Those fan blades have leading edges that are swept forward in an inner region and then swept rearward. However, the prior art does not show such a fan blade having a decreased sweep angle in an outer region.

The following table shows the two alternates of the Count side-by-side.

Count Alternate A	Count Alternate B
A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:	A fan stage of a ducted fan gas turbine engine that is at least in part rotatable about an axis of rotation and defines a downstream direction along the axis of rotation, comprising:
a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region being convergent;	a fan casing that defines an inner duct wall having a fan rotor region, the inner duct wall of the fan casing at the fan rotor region being convergent;

a hub disposed concentrically relative to the fan casing;

a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:

a tip profile that substantially corresponds to the convergent inner duct wall of the fan casing;

a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:

an inner region adjacent the hub, the inner region defining a forward sweep angle;

an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and

an outer region between the intermediate region and the fan casing, the outer region being translated forward relative to the leading edge at an outward boundary of the intermediate region.

a hub disposed concentrically relative to the fan casing;

a fan rotor that includes multiple swept fan blades, the swept fan blades being spaced apart around the hub, each of the multiple swept fan blades having:

a tip profile that is convergent so as to substantially correspond to the convergent inner duct wall of the fan casing;

a leading edge that defines a variable sweep angle in a direction perpendicular to the axis of rotation, the leading edge including:

an inner region adjacent the hub, the inner region defining a forward sweep angle;

an intermediate region between the inner region and the fan casing, the intermediate region defining a rearward sweep angle; and

an outer region between the intermediate region and the fan casing, the outer region defining a forward sweep angle.

Alternate A and Alternate B of the Count define the same patentable invention because the subject matter of each is obvious from the subject matter of the other. 37 C.F.R. § 1.601(n).

As for the obviousness of narrower Alternate B (claim 8 of Patent No. 6,071,077) from broader Alternate A (claim 18 of Application No. 09/874,931), the first limitation in Alternate B not found in Alternate A is the recitation that the blade's tip profile "is convergent so as to substantially correspond to the convergent inner duct wall of the fan casing."

It would have been obvious to use a blade having a convergent tip profile for a number of reasons. First, it was conventional to provide gas turbine engine fans with convergent casings

and matching convergent fan blade tip profiles, as shown by Fig. 1 of Schwaar, Fig. 1 of U.S. Patent No. 4,408,957 to Kurzrock et al. and Fig. 2 of U.S. Patent No. 5,408,826 to Stewart et al. For example, Stewart shows a convergent wall casing and emphasizes the importance of making the radial clearance between the blade tip and wall casing as small as possible to minimize "efficiency damaging air leakage across the blade tips." Stewart, Fig. 2; col. 3, lines 45-50.

Accordingly, the prior art establishes that it would have been obvious to provide Alternate A's fan with a convergent blade tip profile that substantially corresponds to the convergent wall casing.

The only other difference between Alternate A and Alternate B is that Alternate A recites an outer region that is "translated forward relative to the leading edge at an outward boundary of the intermediate region." Alternate B recites this feature more narrowly, calling for an outer region "defining a forward sweep angle."

It would have been a matter of design choice, and thus obvious, to translate Alternate A's already translated-forward outer region further a sufficient amount to provide a forward sweep angle, as recited in Alternate B. The purpose of the claimed blade tip translation is to optimize fan efficiency by moving the tip region leading edge forward a sufficient distance to intercept the shock wave in the vicinity of the blade tip. This is taught both by Application No. 09/874,931, at col. 4, line 63, to col. 5, line 4, and by Patent No. 6,071,077, at col. 7, lines 28-30. See also claim 23 of Application No. 09/874,931. Therefore, it would have been obvious to one of ordinary skill in the art, knowing that to be the purpose of this feature of Alternate A, to translate the blade tip leading edge forward a sufficient amount to provide forward sweep, as called for by Alternate B, if doing so were necessary to achieve the desired purpose for a particular fan.

Accordingly, Alternate B would have been obvious from Alternate A, assuming Alternate A to be prior art with respect to Alternate B in accordance with 37 C.F.R. § 1.601(n) .

In addition, Alternate A is broader in all respects than Alternate B, because Alternate A omits the limitation that the blade tip profile is convergent and recites that the outer region of the blade's leading edge is translated forward rather than swept forward. Thus, Alternate B anticipates Alternate A. M.P.E.P. § 2131.02, Aug. 1991 (8th ed).

CLAIMS CORRESPONDING TO THE COUNT

Claims 1-13 of Patent No. 6,071,077 to Rowlands Are Designated to Correspond to the Count

Claim 1. The difference between claim 1 and Count Alternate B (other than minor differences in terminology) is that claim 1 recites a "stagger angle which increases progressively with blade height," a limitation not found in the proposed Count.

The blade's stagger angle (or "blade twist") increases progressively with blade height because the blade's circumferential velocity ("V_x" in Fig. 2 of Schwaar) progressively increases with blade height, while the axial airflow velocity ("V_y" in Fig. 2 of Schwaar) remains constant. As Schwaar points out, it is a "basic consideration of blade design" that the twist angle "t" shown in Fig. 2 increases with blade height. Schwaar, col. 3, line 66, to col. 4, line 21. Accordingly, this limitation is an inherent feature of any fan blade, and therefore it would at least have been obvious to incorporate it in the fan blade in Alternate B.

Claims 2 and 3. Claim 2 depends from claim 1. It recites a "tip region," but neither it nor its base claim 1 defines this term. Consequently, this claim essentially defines a region of the

blade at the tip that constitutes an arbitrary amount of the blade's span. As a result, this limitation has no patentable significance.

Claim 2's "tip region" could be taken as being that portion of the blade in which the leading edge transitions from the rearward sweep in claim 1's intermediate height region to the forward swept in claim 1's third height region, although that is what claim 3 is understood to add to claim 2. However, if that is the meaning of this limitation, then it would have been obvious to chose any suitable place on the leading edge, such as the last 20% of blade height recited in claims 2 and 3, at which to begin the transition to forward sweep. Put another way, Alternate B teaches a blade with a leading edge profile that has a forward swept outer region in order to provide certain aerodynamic advantages. A gas turbine engine designer of ordinary skill, knowing the purpose of Alternate B's blade geometry (see above), would have found it obvious to provide forward sweep in as much or as little of the blade region near the tip as would be necessary to accomplish that purpose.

As for the recitation of a stagger angle at the blade tip of approximately 70° relative to the airflow direction, this limitation would have been obvious for the same reasons that the recited extent of the forward swept tip region would have been obvious. That is, the engine designer of ordinary skill, faced with a set of fan performance requirements, would have simply made the blade with a stagger angle at the tip that would provide optimum performance. That it might be 70° relative to the airflow direction for a given fan stage is simply a matter of proper engineering design. Note also that the stagger angle "t" at the blade tip as measured in Fig. 2 of Schwaar is 70°.

Claim 4. This claim modifies claim 3, adding that the stagger angle of the mid-height region of the blade is in the range from approximately 30° to approximately 55° relative to the airflow direction.

This claim is obvious from Alternate B for the same reasons as claim 2 discussed above. That is, the stagger angle of a fan blade at any particular point on the blade is simply a function of good design technique after taking into account the operating conditions to be encountered by the blade. In addition, Fig. 6 of Schwaar shows a swept fan blade with a stagger angle between 30° and 55° in the blade mid-height region.

Claim 5. This claim depends from claim 1, and adds the limitation that the sweep angle at any given point on the leading edge is less than the complement of the angle of a Mach cone at any other point on the leading edge of the blade at greater radius from the root.

Initially, it is conventional to use the concept of a "Mach cone" in analyzing supersonic flow over a gas turbine engine fan blade. U.S. Patent No. 3,989,406 to Bliss et al. discusses Mach cone angles, and Figure 2 of Bliss is a three-dimensional depiction of Mach cones associated with a fan blade leading edge. Bliss explains that the Mach cone associated with a particular point is a theoretical construct that makes it possible to envision the character of the flow associated with that point relative to the speed of sound. By definition, flow at the Mach cone normal to its surface is at the speed of sound. Accordingly, flow normal to a leading edge downstream of the Mach cone is subsonic. Bliss, col. 5, lines 21-50. Figure 2 of Bliss illustrates the principle by showing that there is no Mach cone where $M < 1$, that the "cone" is planar at $M = 1$, and that for $M > 1$ the Mach cone angle α increases as the Mach number increases. Bliss

Figure 2 shows a blade with a leading edge swept to a degree that it is always subject to subsonic velocities, thus theoretically eliminating the difficulties associated with shock waves. In geometric terms, the sweep angle in Bliss is greater than the complement of the Mach cone angle α (sweep angle $\sigma > 90° - \alpha$).

One of the reasons for using the blade configuration recited in Alternate B is to account for the presence of shock waves in the flow over the blade. Accordingly, the leading edge of Alternate B's blade inherently is not swept sufficiently to eliminate those shock waves, which is the subject matter of claim 5. That is, if the leading edge of the Alternate B's blade were swept sufficiently to eliminate shock waves, there would be no need to overcome their effects with the leading edge profile recited in Alternate B. Thus, claim 5's subject matter relates to an inherent feature of Alternate B's fan blade, and it would at least have been obvious to incorporate the limitations in claim 5 in Alternate B.

Claim 6. This claim depends from claim 1. It says that the shape of the pressure surface and suction surface of claim 1's blade creates a line of minimum static pressure points on the suction surface of the blade, which line is inclined with respect to the axial direction at a sweep angle which varies with span height of the blade, with a negative value in a region of subsonic flow over the leading edge.

Initially, by definition a gas turbine engine fan blade is an airfoil with a suction surface and a pressure surface. Accordingly, at each location along the blade height, the suction surface will have a minimum static pressure point. The locus of those points will, again by definition, be a line of minimum static pressure points.

As a practical matter, good blade design requires that the line of minimum static pressure points for a swept fan blade inherently follow the leading edge profile, as seen in U.S. Patent No. 4,726,737 to Weingold et al. In other words, given the geometry of Alternate B's blade and its leading edge sweep angle profile, its line of minimum static pressure points will be inclined at a sweep angle that varies with blade height, and that sweep angle will be negative in the inner, subsonic-flow region of the blade.

Claim 7. This claim depends from claim 6, modifying it to add that the sweep angle of the line of minimum static pressure points at a point on the line is less than the complement of a Mach cone angle at any other point on the line.

This claim thus relates to the same concept as claim 5. In addition, analyzing the performance of supersonic fan blades using Mach cones associated with a blade's line of minimum static pressure points was known from Weingold. Fig. 2a of Weingold illustrates Mach cones associated with a line of minimum static pressure points. In Weingold the blade's maximum camber line 42 (associated with the line of minimum pressure points) is behind the Mach line associated with any inboard point of maximum camber. The reason for using this geometry is basically the same as the reason for using the severe sweep discussed in Bliss. Claim 7 simply says that the blade need not be swept as severely as suggested in Weingold if the shock waves' adverse effects are dealt with by reducing sweep in the blade's tip region. That is, according to the claim language, the blade's line of minimum static pressure points is not swept sufficiently to eliminate those shock waves. This feature is inherently part of Alternate B's blade by the same reasoning discussed above in connection with claim 5, and therefore is at least obvious from Alternate B.

Claim 8. This claim is identical to Alternate B.

Claim 9. This claim modifies claim 8 by adding that the blade's intermediate region extends further than the inner region along the fan's axis of rotation. This is a conventional feature of a swept fan blade, shown in Figs. 4 and 6 of Schwaar.

Claim 10. This claim purports to modify claim 8, reciting that the inner duct wall of the fan casing at the fan rotor region is substantially convergent in the downstream direction. However, this is already a feature of Alternate B (claim 8), which means that claim 10 includes nothing to distinguish it from the Count.

Claim 11. This claim purports to modify claim 8, reciting that the tip profile of the swept fan blades are substantially convergent in the downstream direction. As with claim 10, this is already a feature of Alternate B (claim 8), which means that claim 11 also includes nothing to distinguish it from the Count.

Claim 12. This claim recites that the inner duct wall of the fan casing is not parallel to the tip profile of each of the multiple swept fan blades. Accordingly, it contradicts Alternate B, which recites that the blade tip profile is configured to "substantially correspond to the convergent inner duct wall." Nonetheless, it would have been well within the skill of a gas turbine engine designer to use a fan casing with an inner wall that is not parallel to the blade tip profile, as shown in U.S. Patent No. 4,012,165 to Kraig (Fig. 1; movable door 32).

Claim 13. This claim modifies claim 8 by adding that each of the fan blades includes a hub contacting surface that extends further than the tip profile along the axis of rotation.

A gas turbine engine fan designer of ordinary skill determines a fan blade's configuration to meet specified performance parameters. Claim 13 relates to physical properties of the blade

rather than its aerodynamic performance. The features recited in this claim are nothing more than the result of an engine designer of ordinary skill determining optimum blade geometry within the parameters given. In addition, Fig. 4 of Schwaar shows a swept fan blade with the claimed relationship between the blade root and tip.

Accordingly, all of the claims of Patent No. 6,071,077 are either anticipated by or obvious from the Count. By the same token, all of the patent claims, being narrower than (or, in the case of claim 8, identical to) the Count, anticipate the Count. M.P.E.P., supra.

Claims 10, 11, 13-20, 22, and 23 of Application No. 09/874,931 to Spear et al. Are Designated to Correspond to the Count

Claim 10. This claim modifies Alternate A by adding that the blade's "stagger angle which increases progressively with blade height." This is the same manner in which U.S. Patent 6,071,077 claim 1 differs from Alternate B, so Application No. 09/874,931 claim 10 is obvious from the Count for the same reasons discussed above in connection with Patent No. 6,071,077 claim 1.

Claims 11 and 13-17. These claims are either identical to or based closely on dependent claims 2-7 of Patent No. 6,071,077, respectively. To the extent they differ from those patent claims, they are broader. Accordingly, they are obvious from the Count for the same reasons discussed above in connection with Patent No. 6,071,077 claims 2-7.

Claim 18. This claim is identical to Alternate B.

Claims 19, 20, and 22. These claims are either identical to or based closely on dependent claims 9, 10, and 13 of Patent No. 6,071,077, respectively. To the extent they differ from those

patent claims, they are broader. Accordingly, they are obvious from the Count for the same reasons discussed above in connection with Patent No. 6,071,077 claims 9, 10, and 13.

Claim 23. This claim includes functional language setting out the purpose of the blade configuration recited in both alternative versions of the Count. As such, it merely states an advantage inherent in the proposed Count's subject matter, and thus would have been obvious therefrom.

Accordingly, all of the claims of Application No. 09/874,931 are either anticipated by or obvious from the Count. By the same token, all of the application claims, being narrower than (or, in the case of claim 18, identical to) the Count, anticipate the Count. M.P.E.P., supra.

Benefit of the Filing Date of Earlier Applications

Application No. 09/874,931 is a continuation of Application No. 09/343,736, filed on June 30, 1999, to reissue U.S. Patent No. 5,642,985, issued on July 1, 1997, from Application No. 08/559,965, filed on November 17, 1995. Since all of those applications share a common disclosure, Application No. 09/874,931 is entitled to benefit of the November 17, 1995, filing date of Application No. 08/559,965.